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Research article

How do large-scale agricultural investments affect land use and the environment on the western slopes of Mount Kenya? Empirical evidence based on small-scale farmers' perceptions and remote sensing

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ABSTRACT

Africa has been heavily targeted by large-scale agricultural investments (LAIs) throughout the last decade, with scarcely known impacts on local social-ecological systems. In Kenya, a large number of LAIs were made in the region northwest of Mount Kenya. These large-scale farms produce vegetables and flowers mainly for European markets. However, land use in the region remains dominated by small-scale crop and livestock farms with less than 1 ha of land each, who produce both for their own subsistence and for the local markets. We interviewed 100 small-scale farmers living near five different LAIs to elicit their perceptions of the impacts that these LAIs have on their land use and the overall environment. Furthermore, we analyzed remotely sensed land cover and land use data to assess land use change in the vicinity of the five LAIs. While land use change did not follow a clear trend, a number of small-scale farmers did adapt their crop management to environmental changes such as a reduced river water flows and increased pests, which they attributed to the presence of LAIs. Despite the high number of open conflicts between small-scale land users and LAIs around the issue of river water abstraction, the main environmental impact, felt by almost half of the interviewed land users, was air pollution with agrochemicals sprayed on the LAIs' land. Even though only a low percentage of local land users and their household members were directly involved with LAIs, a large majority of respondents favored the presence of LAIs nearby, as they are believed to contribute to the region's overall economic development.

1. Introduction

The global land rush, fueled by the 2007–2008 global food price crisis, has targeted Africa more than any other continent (The World Bank, 2011). Today, implemented land deals in Africa cover about 10 million hectares (Nolte et al., 2016). Agricultural investments into what is often considered "idle" or "underused" land have been propagated as potential win–win situations that enable an increase in agricultural production while at the same time alleviating poverty (Collier and Dercon, 2014). Whether current large-scale agricultural investments (LAIs) can live up to these expectations largely depends on the type of impacts and spillover effects they have on small-scale farmers living in their vicinity (Deininger and Xia, 2016). Even though the phenomenon of LAIs has attracted widespread attention, and despite concerns about small-scale farmers losing access to land and other vital livelihood resources and LAIs leading to environmental degradation, only few studies have comprehensively examined the impacts of LAIs on small-scale farmers' land use and livelihoods.

Unlike the Land Matrix Initiative (Nolte et al., 2016), we interpret the word "large-scale" in "large-scale agricultural investments" as referring not only to the size of the cultivated area, but also to economic size in terms of capital involved and labor employed. Accordingly, in the context of this study, an LAI need not necessarily cover a large area if it involves a great amount of capital or has a large number of employees.

To date, studies on the impacts of LAIs have looked mainly at

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how LAIs affect the labor market, finding in many cases that small-scale farmers benefit from employment generation (The World Bank, 2014). One frequently anticipated positive spillover is the adoption of improved agricultural practices by small-scale farmers as they acquire new skills and knowledge while working for LAI enterprises. This hypothesis was supported by Deininger and Xia (2016), who analyzed agricultural census data for Mozambique and found that spillover effects further included access to inputs and demand for labor. In a case study in Ethiopia, Negash and Swinnen (2013) observed increased food productivity on small-scale farms due to income generated through sales of biofuel crops.

A global meta-analysis showed that adverse impacts of LAIs on livelihoods mainly included loss of access to land and natural resources, increased conflicts, and material or procedural inequality within communities (Oberlack et al., 2016). German et al. (2013) looked at four cases of LAIs in Africa and found the main negative impact of LAIs on smallholders to be smallholders' loss of customary land rights. In terms of environmental impacts, an increase in water scarcity is the most frequently anticipated adverse effect, as it was shown that access to water resources is an important factor in the choice of the location of a future LAI (Breu et al., 2016; Rulli et al., 2013). Nevertheless, only few studies so far have investigated the empirical impacts of LAIs on local water availability and quality (except Muriithi and Yu, 2015; von Maltitz et al., 2016). Furthermore, the understanding of LAI impacts on other ecosystem services remains limited. LAIs may affect ecosystem services not only directly, for example when diversified extensively used cropland is converted into an intensively managed monocultural plantation, but also indirectly, due to changes in small-scale farmers' crop management or the displacement of land use activities. Populations living in the vicinity of rice and teak production companies in Tanzania observed that the LAI had blocked wildlife migration routes (Johansson and Isgren, 2017). In Ghana, small-scale farmers' loss of land to jatropha companies forced them to shorten fallow periods on their remaining land and consequently led to soil degradation (Acheampong and Campion, 2014; Schoneveld et al., 2011). Direct and indirect impacts on land use were observed in Zambia, where smallholders introduced jatropha on their plots and established new plots in forest areas to cultivate displaced food crops (German et al., 2011). In Mozambique, biodiversity-rich *miombo* woodlands were cleared for jatropha plantations, decreasing ecosystem services provision by these woodlands (von Maltitz et al., 2016).

Kenya's agricultural sector has focused considerably on export since colonial times (Deininger and Binswanger, 1995). Kenya is also among those African countries that both domestic and foreign private agricultural investors target (FIAN, 2010). Nevertheless, smallholders' agricultural production accounts for 75% of the country's total agricultural output (Government of Kenya, 2010). Along with the area around Naivasha (Kirigia et al., 2016), Laikipia County on the western slopes of Mount Kenya is one of the prime areas for flower and vegetable production. In the past century, this region underwent several dramatic land use and socio-economic transitions. First, land use changed from pastoralist to colonial large-scale farming and ranching; then, it changed back to small-scale uses after the postcolonial subdivision of former large-scale ranches and the immigration of peasant households (Wiesmann, 1998); and starting in the late 1980s, it shifted towards highly technicized export-oriented greenhouse agriculture by commercial horticulture and floriculture farms (Kiteme et al., 2008). Their produce is mainly exported to European markets to satisfy consumers' demand for year-round fresh vegetables and flowers (Dolan, 2005). In 2013, 35 LAIs were producing mainly vegetables (broccoli, runner beans, kale, French beans, etc.) and flowers (mainly roses) for export to European markets (Lanari et al., 2016). The expansion of LAIs along the western slopes of Mount Kenya exacerbated water scarcity in the area—especially in the dry season, which coincides with peaks in European consumer demands, leading to conflicts (Wiesmann et al., 2000). However, while overall water use in the dry season has increased, the reliance on river water has decreased. In 2013, only 10–31% of the water used by the floriculture and horticulture sectors during the dry seasons was taken from rivers, while the rest was sourced from ground- and storage water (Lanari, 2014). A study based on qualitative interviews with small-scale farmers in the same area showed that over-abstraction of river water and the pollution of water sources with chemicals were the two main environmental impacts that small-scale farmers attributed to LAIs (Ulrich, 2014). Muriithi and Yu (2015) measured water quality in selected rivers in Laikipia and Meru and found that total dissolved solids, electrical conductivity, and salinity had increased in concentration and traces of cadmium, phosphates, and zinc were present near large-scale intensive horticulture farms. However, while the livelihood systems of small-scale farmers in the region have been studied intensively for more than 20 years (e.g. Kohler and Wiesmann, 2003; McCord et al., 2015; Ogalleh et al., 2012; Roden et al., 2016; Ulrich et al., 2012; Wiesmann, 1992), little is known about how land use has changed in the surroundings of LAIs and how small-scale farmers have adapted their land use in the context of LAIs. While it is assumed that part of the local population has been temporarily employed by LAI companies, it remains unknown whether these households have adopted new agricultural practices and applied them on their own farms.

Therefore, the aim of this study was to identify perceived impacts of large-scale floriculture and horticulture farms on small-scale farmers' land use and on the overall environment on the western slopes of Mount Kenya. Based on the analysis of interview data and remotely sensed spatial data, we sought to answer the following research questions: (1) To what extent, and how, did small-scale farmers change their land use, and are these changes related to the presence of LAIs in their neighborhood? (2) Which direct environmental impacts do small-scale farmers perceive LAIs to have? (3) Do small-scale farmers perceive LAIs to have had off-site impacts on land use, and if so, can we confirm this by remote sensing? The overall goal was to provide more comprehensive evidence regarding direct and indirect impacts of LAIs on social-ecological systems northwest of Mount Kenya.

2. Material and methods

2.1. Study area

Our study area is situated on the western slopes of Mount Kenya, within the upper Ewaso Ng'iro basin, and includes parts of Laikipia, Meru, and Nyeri counties (Fig. 1). Climatic conditions range from semihumid (1000–1500 mm of rainfall annually) near Mount Kenya in the east to semiarid (400–900 mm rainfall) and arid (about 350 mm rainfall) towards the west (Berger, 1989). Two distinct rainy seasons determine the cropping calendar, with long rains lasting from mid-March to mid-June (sowing and planting time) and short rains from mid-September to the end of December. The majority of the rural population are small-scale farmers; on less than 1 ha of land per household, they practice a combination of crop farming and livestock keeping, mostly for subsistence but partly also for sale on local markets. In the drier lowland areas, purely pastoral systems dominate. The towns of Nanyuki, Naro Moru, and Timau are the area's main economic centers. The presence of LAIs has increased considerably, from 24 in 2003 to 35 in 2013 (Lanari, 2014); this development has been coupled with the emergence of a remarkable number of greenhouses and open water